X-513-67-298

NASA TM X- 55849

OPERATION PLAN 18-67
OFFICE OF
NAVAL RESEARCH/RICE UNIVERSITY
SATELLITE AURORA-1

JUNE 1967

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

FOR OFFICIAL USE ONLY

NASA - GSFC
OPPLAN 18-67

OFFICE OF NAVAL RESEARCH/RICE UNIVERSITY SATELLITE (AURORA-1)

The purpose of this Operations Plan is to provide information for the activities concerned and to serve as a guide during operations. Amendments will be issued as necessary.

Prepared by:

Project Operations and Support Division
Tracking and Data Systems
NASA - GSFC

Approved by: Albert G. Ferris — Chief, Project Operations and Support Division
Albert G. Ferris

Approved by: ______________________ Project Manager
Brian J. O'Brien

NASA - GSFC
OPPLAN 18-67

OFFICE OF NAVAL RESEARCH/RICE UNIVERSITY SATELLITE
(AURORA-1)

REVIEW AND CONCURRENCE SHEET

Tracking and Data Systems Manager	R. L. Mitchell
Control Center Operations Manager	G. Demas
Tracking and Telemetry Engineer	John B Martin J. B. Martin
Orbital Computations Engineer	W. S. Soar
Communications Engineer	for L. L. Stewart, Jr.
Recording Techniques Engineer	V. H. Byrd
Head, Network Assurance Group	John B Martin J. B. Martin
Chief, Network Engineering and Operations Division	H. L. Hoff
Head, Project Operations Branch	H. R. Lynn
Head, Operations Center Branch	C. L. Maskaleris
Head, Communications Operations Branch	G. A. Cassels

PRECEDING PAGE BLANK NOT FILMED.

TABLE OF CONTENTS

SECTION 1
MISSION

SECTION 2
RESPONSIBILITIES

SECTION 3
ORGANIZATION

SECTION 4
PROJECT IMPLEMENTATION

TABLE OF CONTENTS (Cont)

SECTION 4

PROJECT IMPLEMENTATION

SECTION 5

OPERATIONS AND CONTROL

SECTION 6

FIELD STATION OPERATION

TABLE OF CONTENTS (Cont)

SECTION 6

FIELD STATION OPERATION

SECTION 7

NASA-GSFC COMMUNICATIONS CENTER OPERATIONS

SECTION 8

COMPUTING CENTER OPERATIONS

SECTION 9

DATA PROCESSING

SECTION 10

COMPOSITE COUNT-DOWN

APPENDICES

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION 1

MISSION

SECTION 1

MISSION

1.1 AURORA-1 MISSION

The mission of the Aurora-1 spacecraft is to investigate the following:

- Aurorae and airglow light emitted by the atmosphere in the northern hemisphere.
- Charged particles that bombard the atmosphere in the northern hemisphere.
- Van Allen radiation during the first few weeks in orbit.

1.2 AURORA-1 OBJECTIVES

The Aurora-1 mission will be carried out by meeting the following objectives:

- Studying particles with energies between 50 and 150,000 electron volts (ev).
- Measuring auroral and airglow light at 3914, 5577, 6300, and 1450 to 1750 Angstrom (Å) emitted by the atmosphere.
- Surveying daytime auroras.

In addition, Aurora-1 will provide the first in-space test of several key scientific instruments to be used in a later spacecraft project designated OWL.

SECTION 2

RESPONSIBILITIES

SECTION 2

RESPONSIBILITIES

2.1 GODDARD SPACE FLIGHT CENTER

The Goddard Space Flight Center (GSFC), Tracking and Data Systems Directorate (T&DS), has been assigned telemetry data acquisition responsibility for the Aurora-1 on a noninterference basis with NASA spacecraft operations.

2.1.1 PROJECT OPERATIONS SUPPORT

The Project Operations Support Division is responsible for T&DS coordination, planning and liaison with the project, development of the Operations Plan, and spacecraft operations scheduling and control.

2.1.2 DATA ACQUISITION

The Network Engineering and Operations Division is responsible for telemetry data acquisition from launch throughout the active scientific lifetime of the Aurora-1 spacecraft, nominally for one year.

2.1.3 ORBITAL COMPUTATIONS

The Naval Space Surveillance System is responsible for tracking the Aurora-1 spacecraft and for providing the initial and updated orbital elements to GSFC. The Data Systems Division is responsible for determining and publishing STADAN station predictions based on the elements provided by the Naval Space Surveillance System. The GSFC requires that orbital elements be sufficiently accurate to permit generation of station predictions to within $\pm$ 1 minute.

2.1.4 DATA PROCESSING

The Information Processing Division is responsible for periodically examining representative samples of recorded magnetic tapes from each participating STADAN station to ensure that the quality of the recorded data is in accordance with the project requirements and the STADAN capability. This will be accomplished prior to the tapes being shipped to the Project Office. The STADAN has no responsibility for decommutation or demodulation of the telemetry data.

2.2 OFFICE OF NAVAL RESEARCH (ONR)

The Office of Naval Research has the responsibility for management and direction of the Aurora program.

2.3 RICE UNIVERSITY

Rice University is responsible for development, fabrication, assembly and testing of the Aurora-1 spacecraft, and for the processing and analysis of all telemetry data.

2.4 AIR FORCE SPACE SYSTEMS DIVISION (AFSSD)

The Space System Division, Air Force Systems Command, is responsible for management of the booster system, including launch vehicle preparation, flight testing and conducting launch operations.

SECTION 3

ORGANIZATION

SECTION 3

ORGANIZATION

3.1 PROJECT MANAGER

Professor Brian J. O'Brien is the Project Manager for the Aurora-1 program. In this capacity, Professor O'Brien has overall responsibility for design, fabrication, integration and testing of all spacecraft systems; for the coordination of data requirements; and for the processing and analysis of all telemetered data.

3.2 TRACKING AND DATA SYSTEMS MANAGER (T&DSM)

The T&DSM, Mr. R. L. Mitchell, is a member of the project staff representing the T&DS Directorate. He manages the ground support effort to ensure that the ground tracking and data acquisition system meets mission requirements and he is responsible for the overall utilizations of all T&DS facilities.

3.3 TRACKING AND TELEMETRY ENGINEER (TATE)

The TATE, Mr. John Martin of the Network Assurance Group, Network Engineering and Operations Division, coordinates the design, engineering, construction and integration of the ground equipment. He establishes the necessary tests, simulations and procedures to ensure an operational ground system.

3.4 CONTROL CENTER OPERATIONS MANAGER (CCOM)

The CCOM, Mr. G. Demas of the Project Operations Branch, directs the operation and maintenance of the Project Operations Control Center.

3.5 ORBITAL COMPUTATIONS ENGINEER (OCE)

The OCE, Mr. W. S. Soar of the Data Systems Division, is responsible for the computation of STADAN station predictions based upon orbital elements provided by the Naval Space Surveillance System.

3.6 COMMUNICATIONS ENGINEER (CE)

The CE, Mr. L. L. Stewart, Jr., of the NASA Communications Division, coordinates the design, procedure, implementation and testing of mission-unique communications.

SECTION 4

PROJECT IMPLEMENTATION

SECTION 4

PROJECT IMPLEMENTATION

4.1 LAUNCH PHASE

The Aurora-1 spacecraft is scheduled to be launched simultaneously with the EGRS-9 spacecraft, by a Thor/Burner-II launch vehicle, from the Western Test Range, California. Both spacecraft will be placed into the same orbit. The Aurora-1 will be the secondary payload aboard the launch vehicle. The launch window is from 2100 to 2200 GMT. Injection will nominally occur at T+2673 seconds, at 60.56° south latitude and 130.34° west longitude. The Aurora-1 spacecraft will be mounted on the side of the launch vehicle and will be separated after the launch vehicle is despun from 90 rpm. Table 4-1 contains the launch vehicle sequence of events.

Table 4-1
Launch Vehicle Sequence of Events

Time After Lift-off (seconds)	Event
0.00	Lift-off
159.0	Thor MECO
161.0	Heat shield separation
168.2	Thor VECO
174.0	Thor separation
305.5	Burner-II ignition
355.5	Burner-II burn-out
495.0	Spin-up
530.5	Burner II separation
2658.0	Payload injection motor ignition
2673.05	Payload injection motor burn-out
8056.0	Despin
8060.5	Spacecraft separation

4.2 ORBITAL PARAMETERS

The nominal orbital elements for the Aurora-1 are:

- Apogee — 2100 nautical miles
- Preigee — 2100 nautical miles
- Inclination — 89.79 degrees
- Period — 173 minutes
- Lifetime — 1 year

The nominal subsatellite plot for the spacecraft is shown in Figure 4-1.

4.3 SPACECRAFT

4.3.1 GENERAL

The Aurora-1 spacecraft is rectangular in construction and weighs approximately 47 pounds. It measures 10 inches high, 14 inches wide and 24 inches deep. Nine complete solar panels and a partial panel are attached to the surface. Antennas are jointed and are folded alongside the spacecraft until payload separation.

The spacecraft will be magnetically oriented by a large Alnico-V permanent magnet approximately six inches long and one inch square. Upon injection into orbit, the magnet will cause the spacecraft to align itself with the earth's geomagnetic vector. Damping will be provided by permeable rods.

The spacecraft is instrumented with a magnetometer and a variety of photometers and spectrometers.

Aurora-1 has no command system.

4.3.2 EXPERIMENT

The experiments on board the spacecraft will investigate aurorae, corpuscular bombardment of the atmosphere, and Van Allen radiation.

Four photometers will measure auroral and airglow light at 3914 Angstrom (Å), 5577 Å and 6300 Å. In addition, an ultraviolet photometer will measure ultraviolet light at 1450 Å to 1750 Å.

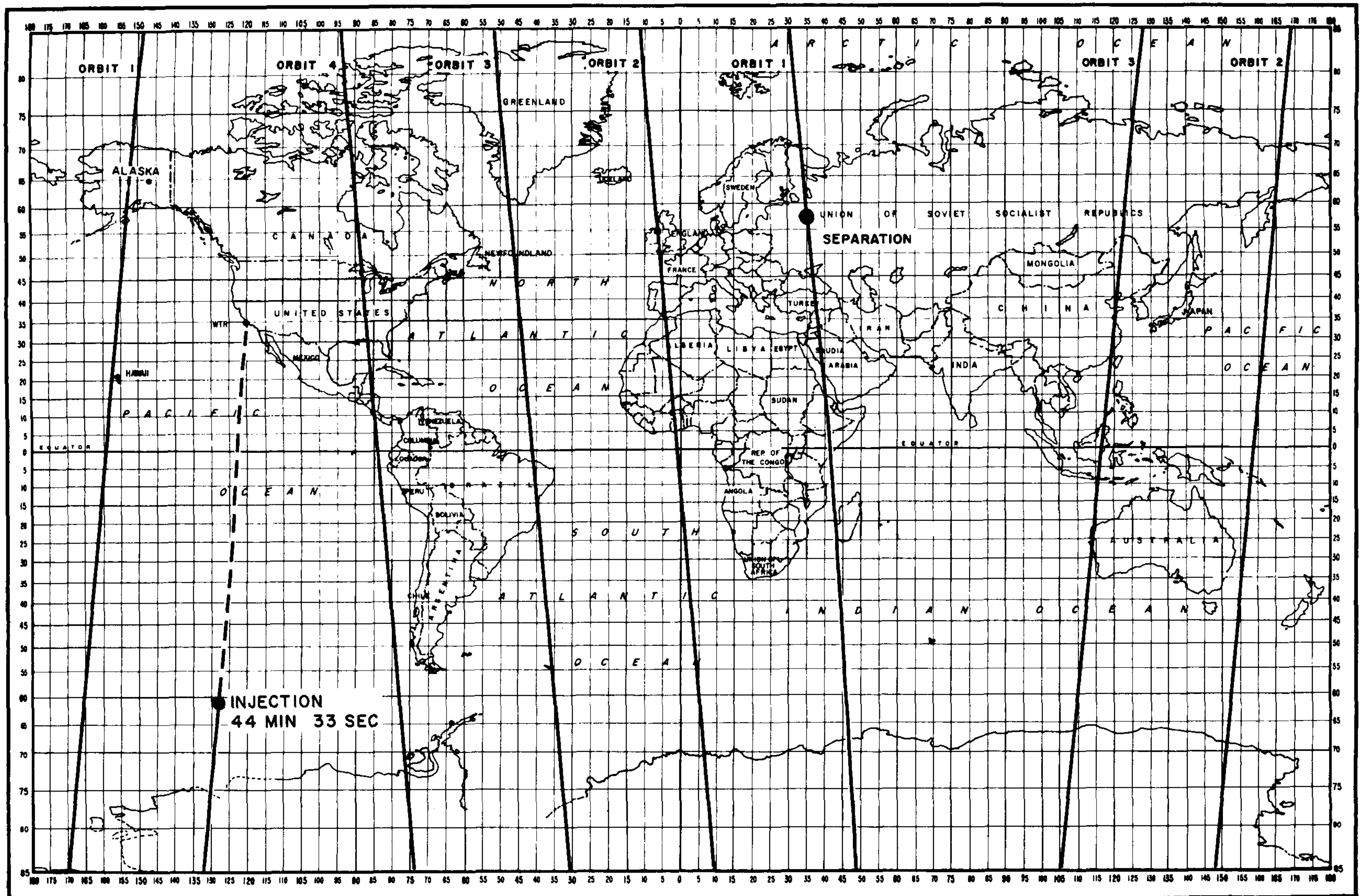


Figure 4-1. Nominal Subsatellite Plot for Aurora-1

Five channeltron spectrometers will be used to study electrons and protons having energy levels between 50 ev and 150 kev that bombard the atmosphere in the northern hemisphere. Another wideband channeltron will study charged particles with energies between 40 ev and 100 kev.

A magnetometer will also be included on the spacecraft to give information about its orientation with respect to the earth's magnetic field.

4.3.3 TELEMETRY SYSTEM

The Aurora-1 telemetry will use an FSK/FM/PM system operating on a frequency of 137.140 MHz with a radiated power of approximately 600 mw. The spacecraft is instrumented as indicated in Figure 4-2. Standard IRIG channels 5 through 9 are utilized. An end-of-life timer will terminate transmission after one year in orbit.

IRIG channels 6 through 9 are similar in that the output of each detector is digitized and fed to a scaler. Three taps are made on each scaler and these cause small, medium and large frequency shift deviations of the appropriate subcarrier oscillators.

For the first 16 days after launch, the output of the magnetometer is transmitted on channel 6. After 16 days, channel 6 is automatically switched to an ultraviolet photometer, and the magnetometer output is commutated and transmitted on channel 5.

The output of the quadrant photometer is transmitted on IRIG channel 8. The quadrant photometer consists of four photometers which are scanned in sequence. A start pulse indicating the start of a sequence is commutated and transmitted on channel 5.

IRIG channel 9 is used to transmit the output of the switchable proton electron channeltron spectrometer (SPECS). The SPECS consists of five channeltron detectors which have a sequence of six voltages applied to them. At each voltage, the outputs of all detectors are scanned and transmitted. The six voltage levels are indicated by a staircase voltage which is transmitted on channel 5.

IRIG 5 is used for transmitting housekeeping data, sequence start of the quadrant photometer, data from a wide-band channeltron, magnetometer data, and the voltage levels applied to the SPECS. The input to channel 5 is alternately

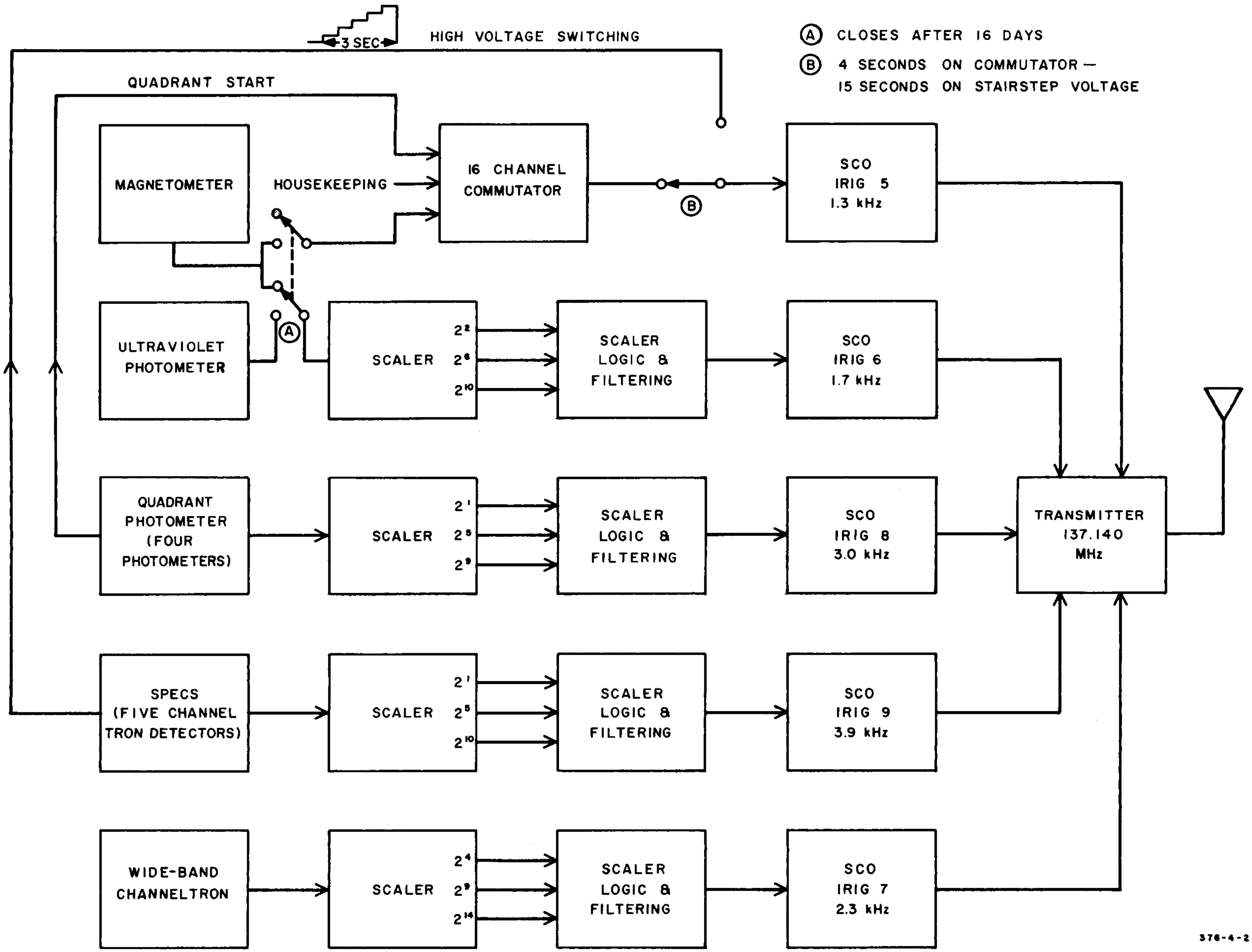


Figure 4-2. Simplified Block Diagram of Aurora-1 Telemetry System

switched between a 16-channel commutator and the 6-level staircase voltage from the SPECS. Switching times are 4 seconds on the commutator and 15 seconds on the staircase voltage. The commutated output contains housekeeping and detector data as outlined above.

The five IRIG subcarriers phase-modulate the 137.140 MHz transmitter with a modulation index of 1.0 radians peak. The antenna elements are fed in pairs and are connected as a turnstile antenna. The radiation pattern is omnidirectional and circularly polarized.

4.3.4 POWER SUPPLY

Electrical power is generated by approximately 1700 solar cells mounted on the surface of the spacecraft. The solar cells charge an array of nickel-cadmium batteries which supply power for the experiments and telemetry. The solar cells will supply an average of four watts after radiation degradation from one year in orbit. The telemetry system will operate continuously unless the batteries become discharged. If the batteries become discharged beyond 80 percent of capacity, a low-voltage cut-off turns the spacecraft off. A timing circuit provides up to 24 hours of charging time for the batteries before turning the spacecraft back on.

SECTION 5

OPERATIONS AND CONTROL

SECTION 5
OPERATIONS AND CONTROL

5.1 INTRODUCTION

The operation and control of the GSFC Space Tracking and Data Acquisition Network (STADAN) ground support facilities utilized for the Aurora-1 spacecraft are the responsibility of the GSFC Tracking and Data Systems Directorate. The organization, facilities, and operational procedures utilized for discharging this responsibility are specified in this section.

5.2 LAUNCH AND EARLY-ORBIT PHASES

During the launch and early-orbit phases of the mission, control of STADAN is the responsibility of the Tracking and Data System Operations Director. This control will be exercised from the GSFC Operations Control Center (OPSCON). The Space Physics Operations Control Center (SPOCC) will be responsible for coordinating Aurora-1 operations, and will be kept informed of launch progress. The following paragraphs briefly discuss the personnel who will be in attendance during the launch, the communications which will be available, and the displays which will be maintained in OPSCON during the launch activities.

5.2.1 OPERATIONS CONTROL CENTER

The following personnel are responsible to the T&DS Operations Director for the efficient operation and control of the GSFC ground support facilities:

- Assistant Operations Director
- Tracking and Data Systems Manager
- Tracking and Telemetry Engineer
- Operations Controller
- NASCOM Communications Manager
- Orbital Computations Engineer
- Display Manager

Additional personnel will be appointed by the Operations Director as dictated by project requirements.

5.2.2 LAUNCH COMMUNICATIONS

During the prelaunch, launch and early-orbit phases, launch communications will be required between OPSCON and other participants for purposes of liaison, coordination and data collection. Figure 5-1 illustrates the composite communications network established for the Aurora-1 and EGRS-9 launch.

5.2.3 DISPLAYS

Prelaunch and real-time launch data pertaining to the mission will be displayed on illuminated screens located at the front of OPSCON. The Operations Center Branch is responsible for the implementation and operation of these displays. The following information will be displayed during the launch and early-orbit phases (these displays will pertain both to the Aurora-1 and to the EGRS-9):

NOTE

> All of the information discussed in the following paragraphs may not be displayed simultaneously. Displays will be projected as appropriate data are received.

5.2.3.1 Station Status

The current status of each participating STADAN station will be shown by means of individual colored lights placed at the geographic station locations on the World Map. The lights indicate the following:

- Amber - station not reported or status unknown.
- Red - station not ready.
- Green - station ready.
- Flashing Green - acquisition of spacecraft signal.

5.2.3.2 Launch Events and Orbital Elements

This display will present the nominal sequence of events during launch, the nominal orbital elements and other pertinent information related to the launch vehicle and spacecraft.

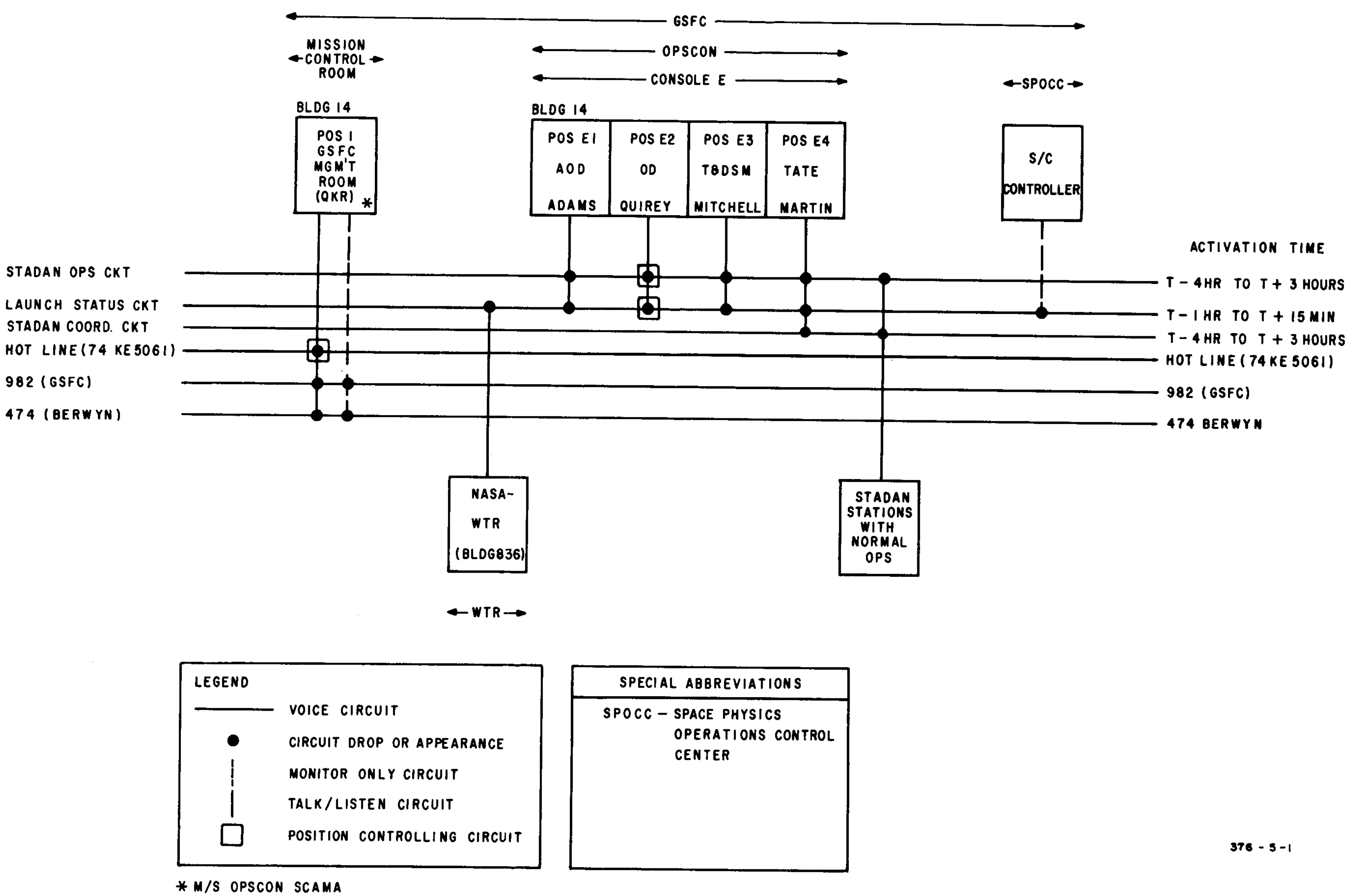


Figure 5-1. Aurora-1 Telephone Communications

5.2.3.3 Teletype Message Display

This display will be used to view projected mission-oriented teletype messages to and from the launch site and supporting ground stations.

5.2.3.4 Subsatellite Plot Display

The nominal subsatellite plot for one full orbit will be displayed. The position of the spacecraft along this plot will be indicated in real-time if near-nominal orbit is achieved. It is expected that the subsatellite plot display will be maintained for not more than three hours.

5.2.3.5 Count-down Clock

The count-down clock will indicate in real-time the latest range count as received in OPSCON from the WTR. Hold times also will be indicated.

5.2.3.6 GMT Clock

A clock indicating Greenwich Mean Time (GMT) is mounted directly above the count-down clock.

5.2.3.7 Telemetry Schedule

This schedule sequentially shows the stations which are scheduled to acquire spacecraft telemetry data and the predicted acquisition times.

5.2.4 STADAN CONTROL

During the launch and early-orbit phases, the Operations Center Branch is responsible for:

- Scheduling and monitoring the operations of the STADAN stations to ensure that telemetry data are recorded in accordance with project requirements and station capabilities. (See paragraph 5.3.5.)

  NOTE

  Since the Aurora-1 orbit will initially be identical with the EGRS-9 orbit, STADAN acquisition of Aurora-1 telemetry will be scheduled in accordance with nominal and post launch orbital computations for EGRS-9 until Aurora-1 orbital elements are received from Naval Space Surveillance System.

- Providing the T&DSM with periodic reports concerning the network telemetry activities. Unusual activities will be reported in near-real-time to the Space Physics Operations Control Center (SPOCC).

A summary STADAN activity report will be prepared no later than 0600 hours local time on each of three consecutive days following launch and transmitted to the SPOCC. This report will include such information as the number of minutes of telemetry recorded by the stations and any unusual occurrences.

- Providing the SPOCC with a copy of the initial telemetry acquisition schedule, pass changes if made, and updated or new schedules as they become available.
- Ensuring operation of appropriate displays.
- Checking with the Minitrack Section and the Communications Operations Branch to ensure that the nominal predictions have been disseminated to all STADAN facilities participating in the Aurora-1 mission.
- Keeping the Tracking and Data Systems Manager informed of the ability of STADAN to support the Aurora-1 mission when requested, beginning at T-1 day.
- Ensuring that the STADAN stations are aware of their assigned responsibilities.

5.2.5 GSFC PROJECT OPERATIONS CONTROL

The Tracking and Data Systems Manager of the Project Operations Branch is responsible for:

- Providing the Operations Center Branch with a recommended Launch Access List by T-10 days. This list will show those personnel requiring access to the Operations Control Center and OPSCON Observer Area during the launch and early-orbit phases. Personnel will be listed by name, organization, function, and relationship to the Aurora-1 project.
- Providing the Network Control Group, by T-10 days, with the initial data acquisition requirements in accordance with the requirements of the project.
- Maintaining liaison with the Project Liaison Office and the Space Physics Control Center Operations Manager for transmitting spacecraft status as well as receiving and implementing changes

in the project requirements if and when they arise. New requirements are to be coordinated by, and have the concurrence of, the T&DS Manager.

- Assuring that the SPOCC is fully operational and capable of providing the necessary support in accordance with the requirements of the Aurora-1 Project.

5.3 NORMAL PHASE

The normal phase will begin when so directed by the T&DS Operations Director. Unless unforeseen complications develop, this will be after the spacecraft orbit has been determined by the U. S. Naval Space Surveillance System and updated orbital predictions have been computed and forwarded to the ground stations.

5.3.1 STADAN CONTROL

During the normal phase, the Operations Center Branch is responsible for:

- Scheduling and monitoring the operations of the GSFC Space Tracking and Data Acquisition Network (STADAN) stations in accordance with spacecraft priority listings, station capabilities and project requirements. (See paragraph 5.3.5.)

- Providing the SPOCC with STADAN status information throughout the active scientific lifetime of the spacecraft. SPOCC will be provided, via teletype, a copy of the telemetry acquisition schedules, telemetry reports and any changes as they become available. These schedules will be transmitted to SPOCC prior to network implementation except during operational emergencies. Unusual events will not be restricted to a time frame, but will be reported as dictated by the urgency of the situation and the need for a quick response.

5.3.2 PROJECT OPERATIONS AND CONTROL

During the normal phase the Tracking and Data Systems Manager will be responsible for:

- Maintaining liaison with the Project Liaison Office or his designated representative to implement changes in project requirements and handle emergency situations as they arise.

- Maintaining an up-to-date knowledge of the spacecraft status at all times.
- Ensuring the accomplishment of all phases of the project involving the Tracking and Data Systems Directorate.
- Advising the appropriate Tracking and Data Systems Directorate personnel of the project status and ground support activities.
- Monitoring the operation of the Aurora-1 portion of the SPOCC to ensure that project requirements are fulfilled.

5.3.3 SPACE PHYSICS OPERATIONS CONTROL CENTER

The Space Physics Operations Control Center (SPOCC) will be the central point of contact for all GSFC operations regarding the Aurora-1 spacecraft. The SPOCC will be operational throughout the scientific lifetime of the Aurora-1 spacecraft, and SPOCC personnel will ensure that the project requirements are fulfilled.

The SPOCC will have the following information readily available:

- Current Aurora-1 telemetry acquisition schedules
- Latest Aurora-1 orbital elements
- Position of the Aurora-1 spacecraft
- Predicted world maps and station observations
- Records showing the dates that magnetic tapes containing Aurora-1 telemetry data were forwarded to the Project Office.

5.3.4 INFORMATION DISSEMINATION

The Information Dissemination Group of the Operations Center Branch will be responsible for distributing the predicted world map and the predicted station observations each time they are updated to the SPOCC and OPSCON/NETCON.

5.3.5 STADAN SCHEDULING REQUIREMENTS

The following STADAN stations may be used by OPSCON/NETCON for scheduling Aurora-1 telemetry data acquisition support.

ALASKA	QUITOE
FTMYRS	ROSMAN
JOBURG	SNTAGO
ORORAL	WNKFLD

Telemetry data acquisition support will be scheduled at these stations based on the following requirements:

- Data acquisition on two passes per orbit (one northern and one southern hemisphere station) for 16 days after launch.
- After this period, the STADAN will discontinue telemetry acquisition at all stations except ALASKA and WNKFLD. For the remaining life of the spacecraft and as consistent with assigned priorities, the Project requests telemetry acquisition coverage at the rate of two passes per orbit (when practical), using only those stations having a high northern latitude (i.e., ALASKA and WNKFLD).

5.4 SPECIAL NOTIFICATION MESSAGES

The Aurora Project Office will notify the T&DSM via teletype, ten days prior to launch, of the official unclassified Aurora-1 launch date, launch window, and nominal lift-off time. Similar advice will be provided regarding any change in that information. In addition the Aurora Project Office will notify GSFC, via teletype, of the exact lift-off time of the Aurora-1 as soon as possible after launch.

5.4.1 T-10 DAY LAUNCH NOTIFICATION MESSAGE

The following format will be used for the T-10 day launch notification message.

00/0000Z

FM: AURORA PROJECT OFFICE
TO: NASA GSFC GREENBELT MD
ATTN: R. L. MITCHELL CODE 513 INFO GNET GPHY
SUBJECT: AURORA-1 SPACECRAFT

THE AURORA IS SCHEDULED TO BE LAUNCHED AT (INSERT TIME) Z, (INSERT DATE, MONTH, AND YEAR). THE NOMINAL LAUNCH TIMES AND WINDOWS FOR (INSERT NUMBER OF DAYS) DAYS FOLLOW:

DATE	WINDOW OPENS (Z)	WINDOW CLOSES (Z)
X	HRMN	HRMN
X	XXXX	XXXX
X	XXXX	XXXX
X	XXXX	XXXX
X	XXXX	XXXX
ETC	ETC	ETC

REQUEST GSFC COMMENCE OPERATIONS AS SET FORTH IN NASA GSFC OPPLAN 18-67.

00/0000Z (CURRENT MONTH)

5.4.2 OFFICIAL LIFT-OFF NOTIFICATION MESSAGE

The following message format will be used to notify GSFC of the official lift-off of the Aurora-1.

00/0000Z

FM: AURORA PROJECT OFFICE
TO: NASA GSFC GREENBELT MD
ATTN: R. L. MITCHELL CODE 513 INFO GOPS GPHY
SUBJECT: AURORA -1 SPACECRAFT

THE AURORA-1 WAS LAUNCHED ON (INSERT YEAR, MONTH, AND DAY) AT (INSERT OFFICIAL LIFT-OFF TIME IN HOURS, MINUTES, SECONDS, AND TENTHS OF SECONDS) Z. REQUEST GSFC COMMENCE OPERATIONS AS SET FORTH IN NASA GSFC OPPLAN 18-67.

00/0000Z (CURRENT MONTH)

SECTION 6

FIELD STATION OPERATION

SECTION 6

FIELD STATION OPERATION

6.1 TRACKING

The U. S. Naval Space Surveillance System will be responsible for tracking the Aurora-1 spacecraft. Initial and updated orbital parameters and equator crossing times will be supplied to GSFC by the Naval Space Surveillance System so that station look-angles may be computed by the Data Systems Division for STADAN telemetry data acquisition.

6.2 COMMAND

The Aurora-1 spacecraft has no command system.

6.3 DATA ACQUISITION

6.3.1 STATION RESPONSIBILITY

For the first 16 days following launch and when scheduled, STADAN stations cited below will have responsibility for recording telemetered data transmitted on the 600-mw (137.140-MHz) signal from the Aurora-1 spacecraft.

Station Location	Station Code Name
Fairbanks, Alaska	ALASKA
Fort Myers, Florida	FTMYRS
Johannesburg, S. Africa	JOBURG
Orroral, Australia	ORORAL
Quito, Ecuador	QUITOE
Rosman, North Carolina	ROSMAN
Santiago, Chile	SNTAGO
Winkfield, England	WNKFLD

After the first 16 days, support will be scheduled only at the ALASKA and WNKFLD stations.

6.3.2 EQUIPMENT CONFIGURATION FOR AURORA-1

The STADAN station telemetry receive system configuration for Aurora-1 is shown in Figure 6-1. The following paragraphs list equipment parameters which will be utilized for support of this spacecraft.

6.3.2.1 Antenna

- Minimum gain . . . . 19 db
- Polarization. . . . . Circular
- Frequency. . . . . 136—138 MHz

6.3.2.2 Autotrack Receiver

- Frequency. . . . . 137.14 MHz
- Mode . . . . Phase-lock
- Loop bandwidth . . . . 30 Hz
- AGC speed . . . . 30 msec

6.3.2.3 Diversity Telemetry Receiver

- Frequency. . . . . 137.14 MHz
- IF bandwidth . . . . 30 kHz
- AGC speed . . . . 30 msec

6.3.2.4 Phase-lock Demodulator and Combiner

- Mode . . . . PM
- AGC speed . . . . 30 msec
- Loop bandwidth . . . . 30 Hz
- Output bandwidth . . . . 5 kHz

6.3.2.5 Recording Equipment

- Tape speed . . . . 1-7/8 ips

- Track Assignments

Track	Record Amplifier	Signal	Source
1	Direct	Multiplex AGC	Multiplexer
2	Direct	60 Hz on 1 kHz	Time Standard
3	Direct	Raw Data	Diversity Combiner
4	Direct	BCDT on 1 kHz	Time Standard
5	Direct	Raw Data	Diversity Combiner
6	Direct	SCDT on 1 kHz	Time Standard
7	Direct	Voice, WWV Audio	Audio Amp

6.4 QUICK-LOOK DATA

There are no quick-look requirements for the Aurora-1 spacecraft.

6.5 SPACECRAFT - UNIQUE EQUIPMENT

None

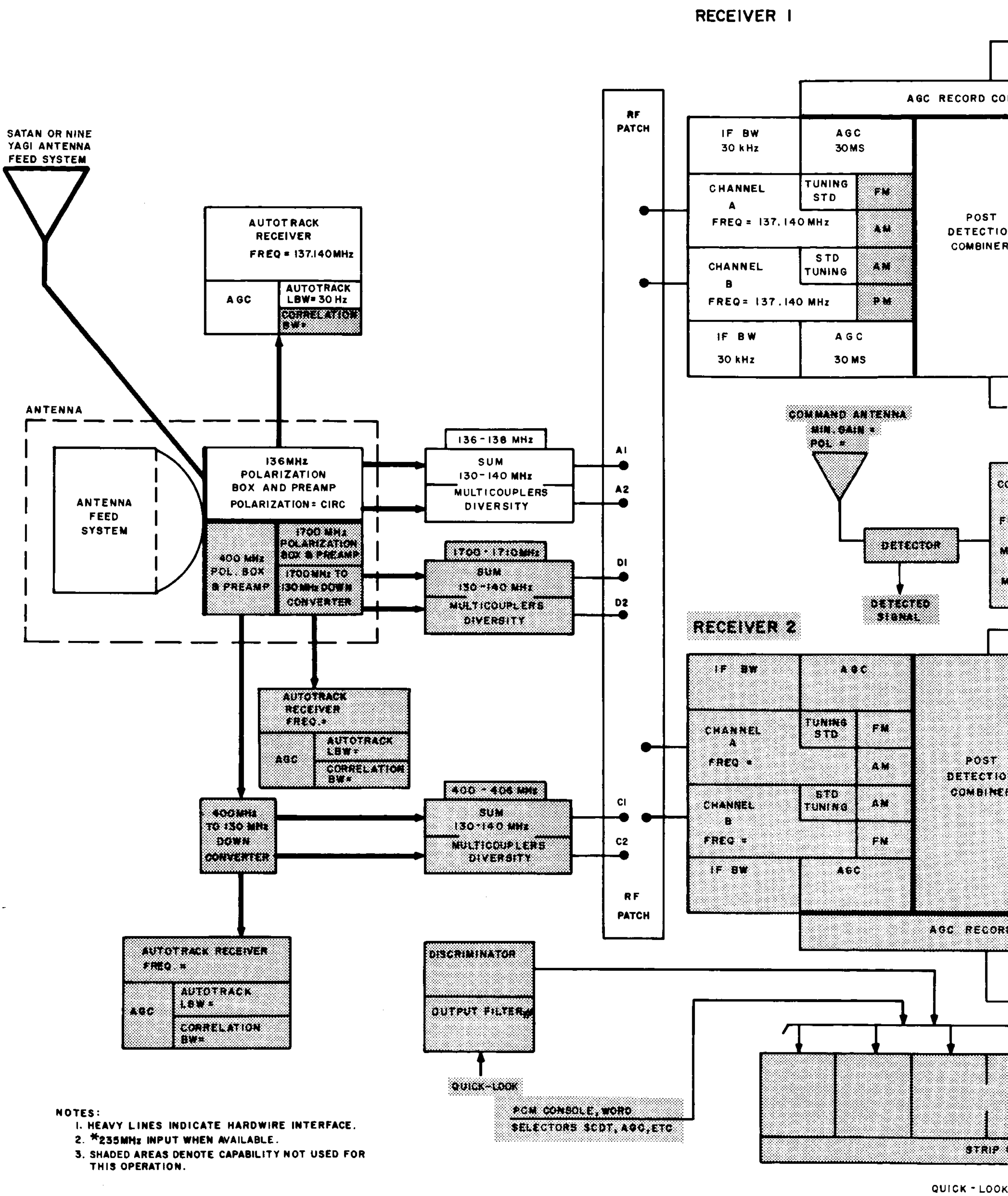
6.6 RECORDED TELEMETRY DATA

All Aurora-1 telemetered data recorded on magnetic tape at the STADAN stations will be forwarded, in accordance with standard tape-shipping instructions, to the following address:

NASA Goddard Space Flight Center
Data Processing Branch
Analog Tape Library, Code 564
Greenbelt, Maryland 20771
U. S. A.

6.7 TELEMETRY REPORTS

Cumulative telemetry reports will be prepared and submitted in accordance with established standard operating procedures.



NOTES:

1. HEAVY LINES INDICATE HARDWIRE INTERFACE.
2. *235MHz INPUT WHEN AVAILABLE.
3. SHADED AREAS DENOTE CAPABILITY NOT USED FOR THIS OPERATION.

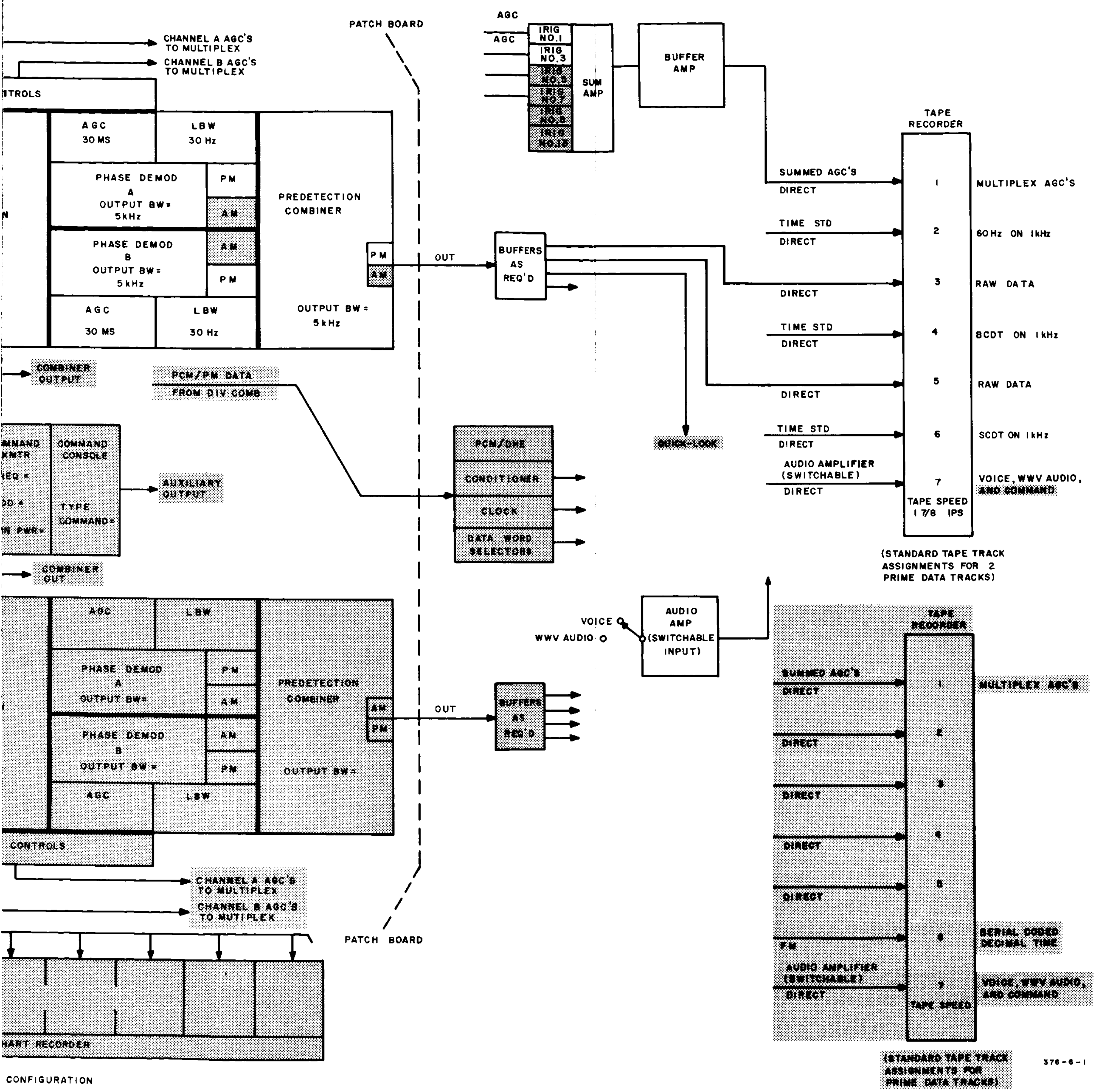


Figure 6-1. Aurora-1 Equipment Configuration

SECTION 7

NASA-GSFC COMMUNICATION CENTER OPERATIONS

SECTION 7

NASA-GSFC COMMUNICATION CENTER OPERATIONS

7.1 LAUNCH AND EARLY-ORBIT PHASES

7.1.1 TELETYPE OPERATIONS

Teletype communications and procedures will be in accordance with NASA Communications Operating Procedures (NASCOP), Appendices B & D. Those participants who are not holders of NASCOP will be served by normal off-net facilities using established commercial procedures.

7.1.2 ADDRESSING TRAFFIC

All mission-oriented traffic will be addressed to GOPS.

7.1.3 VOICE COMMUNICATIONS

Voice communications are provided between the GSFC Operations Control Center and all the participating remote sites, including voice communications with NASA/WTR (Launch Status Circuit).

Switching of the voice circuits required for STADAN operations will be accomplished at the GSFC SCAMA facility as requested by the GSFC Operations Control Center.

7.1.4 NASCOM NETWORK SCHEDULING GROUP (NNSG)

The NNSG will schedule utilization of circuitry within the NASCOM Network to ensure that necessary circuitry is available to meet mission requirements. In addition, those resources of the NASCOM Network which are not initially committed to the mission will be available for use in case of an emergency.

7.2 NORMAL PHASE

All communication procedures will be in accordance with NASCOP.

SECTION 8

COMPUTING CENTER OPERATIONS

SECTION 8

COMPUTING CENTER OPERATIONS

8.1 DATA SYSTEMS DIVISION

The Data Systems Division will be responsible for computing prelaunch and postlaunch station predictions.

8.1.1 INPUT

Prelaunch and postlaunch station predictions will be computed, using orbital elements provided and updated by Naval Space Surveillance Systems.

8.1.2 OUTPUT

Orbital elements, predicted station observations and topocentric coordinate data will be required as indicated in Table 8-1 and Table 8-2.

Prediction world maps will be computed for one-week periods and are required by:

- Space Physics Operations Control Center 1 copy
- Network Controller 2 copies

8.1.3 CDC OUTPUTS

COMPUT will provide the station matrix to NETCON/OPSCON in accordance with normal operating procedures.

Table 8-1
Prelaunch Orbital and Prediction Requirements (Operational Format)

Station	Orbital Elements	Azimuth - Elevation	Topocentric Coordinate Data	
			X-Y Data	ENV
ALASKA	X	X	X	X
CARVON	X		X	
FTMYRS	X	X	X	
JOBURG	X	X	X	X
ORORAL	X	X	X	X
QUITOE	X	X	X	X
ROSMAN	X		X	X
SNTAGO	X	X	X	X
WNKFLD	X	X	X	

Note: Print-outs of all the above predictions are required by:

SPOCC 1 copy
Network Controller 2 copies

Table 8-2
Postlaunch Orbital and Prediction Requirements (Operational Format)

Station	Orbital Elements	Azimuth - Elevation	Topocentric Coordinate Data	
			X-Y Data	ENV
ALASKA	X	X	X	X
FTMYRS	X	X	X	
JOBURG	X	X	X	X
ORORAL	X	X	X	X
QUITOE	X	X	X	X
ROSMAN	X		X	X
SNTAGO	X	X	X	X
WNKFLD	X	X	X	

Note: Print-outs of all the above predictions are required by:

Space Physics Operations Control Center 1 copy

Network Controller 2 copies

Note: After the first 16 days following launch, station predictions are required only for the Alaska and Winkfield stations.

SECTION 9

DATA PROCESSING

SECTION 9

DATA PROCESSING

9.1 PROCEDURES

Processing of the telemetered data from the Aurora-1 will be the responsibility of Rice University. The GSFC Data Processing Branch will, however, be responsible for periodically checking representative samples of recorded magnetic tape from each GSFC data acquisition facility to ensure that the quality of the recorded data is in accordance with the project requirements and the network capability.

The first tape received from each station will be evaluated as soon as practicable for appraisal of station performance. A report concerning the quality of each station tape will be submitted to the Tracking and Data Systems Manager, the Operations Center Branch, and the Operations Support Office after receipt of the initial tape from each of the stations. An interim report will be submitted if a major discrepancy is noted. The Operations Support Office will report to each station any anomalies found. In the event a serious anomaly is found, the T&DSM and NETCON should receive advance notification by phone.

Each week the latest tape received from each station will be run through the tape-evaluation procedure for detailed examination of the quality of the tape and for preparation of a weekly station telemetry report. Copies of this report should be provided to the T&DSM, Operations Support Office and Operations Center Branch.

After evaluation, the Data Processing Branch will forward the tapes via mail to the Aurora-1 Project Manager:

Professor Brian J. O'Brien
Rice University
Department of Space Sciences
Houston, Texas 77001

Professor O'Brien will keep the GSFC Tracking and Data Systems Manager periodically informed of the quality of the recorded data (magnetic tapes) received from GSFC.

SECTION 10

COMPOSITE COUNT-DOWN

SECTION 10

COMPOSITE COUNT-DOWN

10.1 COMPOSITE COUNT-DOWN SCHEDULE

The composite count-down schedule is referenced to the nominal lift-off time and lists only those periods in the Aurora-1 count-down that require action by the GSFC ground support elements and the Aurora Project Office.

Composite Count-down Schedule

Count-down	Action	Responsibility
T-10 Days	Forward notification of nominal launch date and time, and launch window to GSFC.	Aurora Project Office
	Forward notification of nominal launch date and time to all participating STADAN stations.	NETCON
T-3 Days	Ensure that nominal predictions are sent to all participating stations.	Operational Computing Branch
T-1 Day	Alert all stations to be prepared to implement OPPLAN 18-67.	OPSCON
T-4 Hours	Conduct prelaunch RF loop simulations at participating STADAN stations.	OPSCON/stations
T-165 Minutes	Alert all participating STADAN stations that launch is imminent.	OPSCON
	Forward request for station readiness reports to all participating STADAN stations.	OPSCON
T-150 Minutes	Submit first station readiness report to GOPS.	Participating STADAN stations
T-60 Minutes	Establish phone circuit between GSFC OPSCON and NASA/WTR, and receive launch operations status via this circuit.	OPSCON
	Submit second station readiness report to GOPS. (Stations are assumed to be operational after this time unless GOPS is notified otherwise.)	Participating STADAN stations

Count-down	Action	Responsibility
T-15 Minutes to T-0	Receive spacecraft status, transmitting frequency and all pertinent prelaunch countdown in formation from the NASA representative at WTR.	NASA/WTR Liaison/ OPSCON
	Forward pertinent prelaunch information to all participating STADAN stations.	OPSCON
T-0 Minutes	Forward lift-off information to the GSFC via telephone and teletype.	Aurora Project Office
	Forward pertinent launch and post-launch information to all participating STADAN stations.	OPSCON/NETCON
T+15 Minutes	Receive vehicle events status from NASA representation at WTR.	NASA/WTR liaison/ OPSCON

APPENDIX A

AURORA-1 SIGNAL STRENGTH CALCULATIONS

APPENDIX A

SIGNAL STRENGTH CALCULATIONS

(AURORA I)

A.1 SPACECRAFT PARAMETERS

NOTE

The numbers in the right-hand margin of the page refer to the item numbers of the bibliography and indicate the sources of the data.

A.1.1 FLIGHT PARAMETERS

Apogee.	3900 kilometers	(5,6)
Perigee	3900 kilometers	(5,6)
Inclination	89.79 degrees	(1)
Period.	173 minutes	(6)
Spin rate	less than 1 rpm	(1)
Orientation	magnetic axis of spacecraft aligned with geomagnetic vector of the earth	(1)
Angular velocity.	6.01×10^{-4} rad/sec	(6)

NOTE

The flight parameters presented above are approximate values suitable for use in performing signal strength calculations; however, their use in performing precise orbital computations is not recommended. Deviation of the approximate values from the precise values, within the tolerances stated below, may cause an error no greater than $\pm$ 1 db in the calculated signal strengths:

Apogee and perigee. . .	$\pm$ 5 percent	(6)
Inclination	$\pm$ 5 degrees	(6)
Period.	$\pm$10 percent	(6)

A.1.2 RF SYSTEMS PARAMETERS

A.1.2.1 Tracking and Telemetry Link

Carrier Frequency	137.140 MHz	(1)
Carrier Modulation		
Type of modulation.	FSK/FM/PM	(1)
Modulation index.	1.0 radians (pk)	(5,6)
Baseband.	IRIG 5,6,7,8,9	(1)
Total Transmitter Power Output.	28 dbm (600 mw)	(1)
Radiating Antenna Characteristics		
Type of antenna	Turnstile	(5)
Antenna polarization.	Circular	(1)
Maximum antenna gain. . . . . (includes 2 db passive element losses)	+0 db	(5,6)
Expected null depth	-4 ± 4 db	(5)
Effective Radiated Power (maximum antenna gain)		
Total ERP	+28 dbm	(6)
Carrier ERP	+26 dbm	(6)
Sideband ERP.	+24 dbm	(6)
Channel ERP	+17 dbm	(6)

NOTE

The value shown for Channel ERP assumes that the total sideband power is distributed equally among the IRIG channels transmitted (5). Thus, with a total sideband power of 250 mw, each channel is assumed to have a power contribution of 50 mw.

A.2 SLANT RANGE CONSIDERATIONS

The purpose of this paragraph is to present the results of slant range calculations performed by the Network Assurance Group for a circular orbit with an altitude of 3900 kilometers.

The slant ranges of primary interest are the maximum slant ranges encountered with look angles of 10 degrees and 45 degrees, corresponding to the earliest-acquisition look angles of the steerable and Minitrack antennas respectively, and the minimum slant range, corresponding to an antenna look angle of 90 degrees.

Calculations performed result in the following:

Maximum slant range at 10 degrees. . . . 7100 kilometers

Maximum slant range at 45 degrees. . . . 4650 kilometers

Minimum slant range. . . . . 3900 kilometers

A.3 RECEIVED SPECTRAL NOISE POWER CONSIDERATIONS

The purpose of this paragraph is to provide a value for the average spectral noise power density experienced in the 130-150 MHz band.

This value, calculated by the Network Assurance Group, is the received spectral noise power density referred to the antenna preamplifier input, and corresponds to an average antenna noise temperature of 1500° K $\pm$ 1200°. Consideration is also given to typical transmission line losses, and preamplifier noise figures.

The value calculated by the Network Assurance Group is:

$$S_n = -167 \text{ dbm/Hz} \pm 3 \text{ db} \qquad \text{(A-1)}$$

To calculate the received noise in a given bandwidth, the following expression should be used:

$$P_n = S_n + 10 \log - (\text{ENBW}) \qquad \text{(A-2)}$$

where:

P_n = total received noise (dbm)

S_n = spectral noise power density (dbm/Hz)

ENBW = equivalent noise power bandwidth (Hz)

A.4 RECEIVED SIGNAL STRENGTH, TELEMETRY SYSTEMS

The calculations presented in this paragraph pertain to the requirements of phase-lock-loop and diversity polarization reception techniques using the 9-Yagi antenna system.

When considering the use of other antenna systems, the following values should be added to the parameter values indicated with an asterisk (*):

40-foot parabolic antenna.	+ 0 db	(3)
16-Yagi antenna system	+ 2 db	(3)
SATAN receive antenna system	+ 3 db	(3)
85-foot parabolic antenna system	+ 7 db	(6)

Table A-1

Received Signal Strength, 9-Yagi Antenna System

(Phase-lock-loop Requirements)

Parameter	Mean Values 7100 km (Max. Range)	Mean Values 3900 km (Min. Range)	3σ Deviation	Ref
Effective radiated carrier power	+ 26 dbm	+ 26 dbm	$\pm$ 0 db	6
Free-space attenuation	-152 db	-147 db	$\pm$ 0 db	6
Receiving antenna gain*	+ 19 db	+ 19 db	$\pm$ 0 db	3
Passive element losses	- 1 db	- 1 db	$\pm$ 0 db	2
Maximum AGC level*	-108 dbm	-103 dbm	$\pm$ 0 db	6
Expected nulls, due to antenna anomalies and cross-polarization	- 8 db	- 8 db	$\pm$ 5 db	6
Expected minimum level (includes antenna anomalies and cross-polarization)*	-116 dbm	-111 dbm	$\pm$ 5 db	6
Received noise power (30 Hz loop bandwidth)	-149 dbm	-149 dbm	$\pm$ 3 db	6
Minimum received SNR *	+ 33 db	+ 38 db	$\pm$ 6 db	6
SNR required in loop for phase-lock	+ 6 db	+ 6 db	$\pm$ 0 db	6
Signal margin, optimum system *	+ 27 db	+ 32 db	$\pm$ 6 db	6
System operating margin	- 3 db	- 3 db	$\pm$ 3 db	6
Signal margin *	+ 24 db	+ 29 db	$\pm$ 7 db	6

<u>QUALIFICATIONS</u>: Expected nulls assumes a polarization loss of -4 db $\pm$ 3 db.

<u>CONCLUSIONS</u>: No problems anticipated in the reception of sufficient carrier power for phase-lock requirements.

Table A-2

Received Signal Strength, 9-Yagi Antenna System
(Diversity Polarization Telemetry Reception)

Parameter	Mean Values 7100 km (Max. Range)	Mean Values 3900 km (Min. Range)	3σ Deviation	Ref
Effective radiated channel power	+ 17 dbm	+ 17 dbm	± 0 db	6
Free-space attenuation	-152 db	-147 db	± 0 db	6
Receiving antenna gain*	+ 19 db	+ 19 db	± 0 db	3
Passive element losses	- 1 db	- 1 db	± 0 db	2
Maximum received channel power *	-117 dbm	-112 dbm	± 0 db	6
Expected nulls (includes antenna anomalies and cross-polarization)	- 4 db	- 4 db	± 4 db	5
Minimum received channel power *	-121 dbm	-116 dbm	± 4 db	6
Received noise, 586 Hz (IRIG 9 ENBW = 586 Hz)	-139 dbm	-139 dbm	± 3 db	6
Minimum received SNR *	+ 18 db	+ 23 db	± 5 db	6
SNR required in discriminator	+ 12 db	+ 12 db	± 0 db	6
SNR margin, optimum system *	+ 6 db	+ 11 db	± 5 db	6
System operating margin	- 3 db	- 3 db	± 3 db	6
Signal margin *	+ 3 db	+ 8 db	± 6 db	6

QUALIFICATIONS: Expected nulls assumes a polarization loss of 0 db.

CONCLUSIONS: No problems anticipated in the reception of sufficient channel power for the reception of telemetry data.

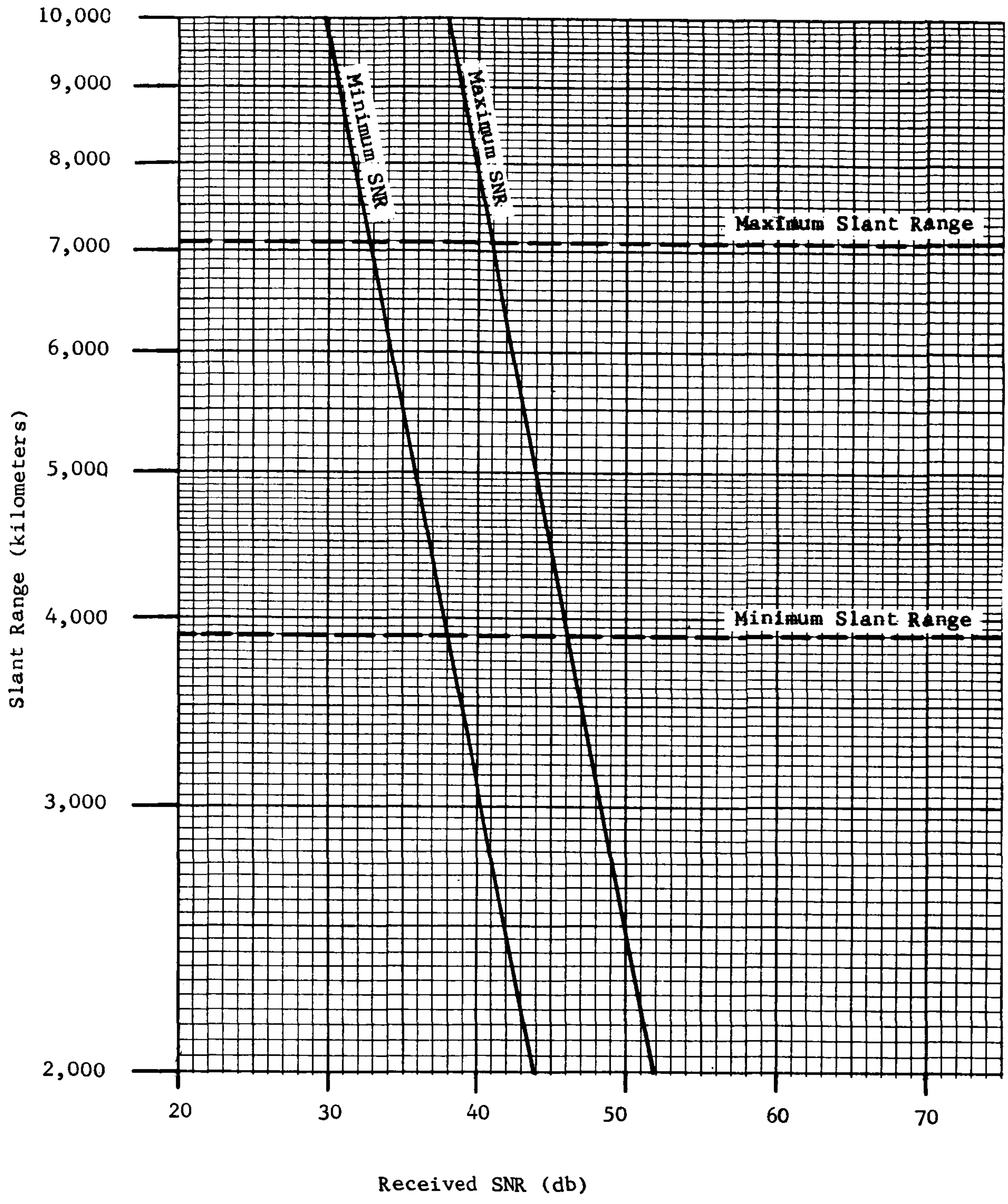


Figure A-1. Received Signal-to-Noise Power Ratio, 9-Yagi Antenna System (Phase-lock-loop Requirements)

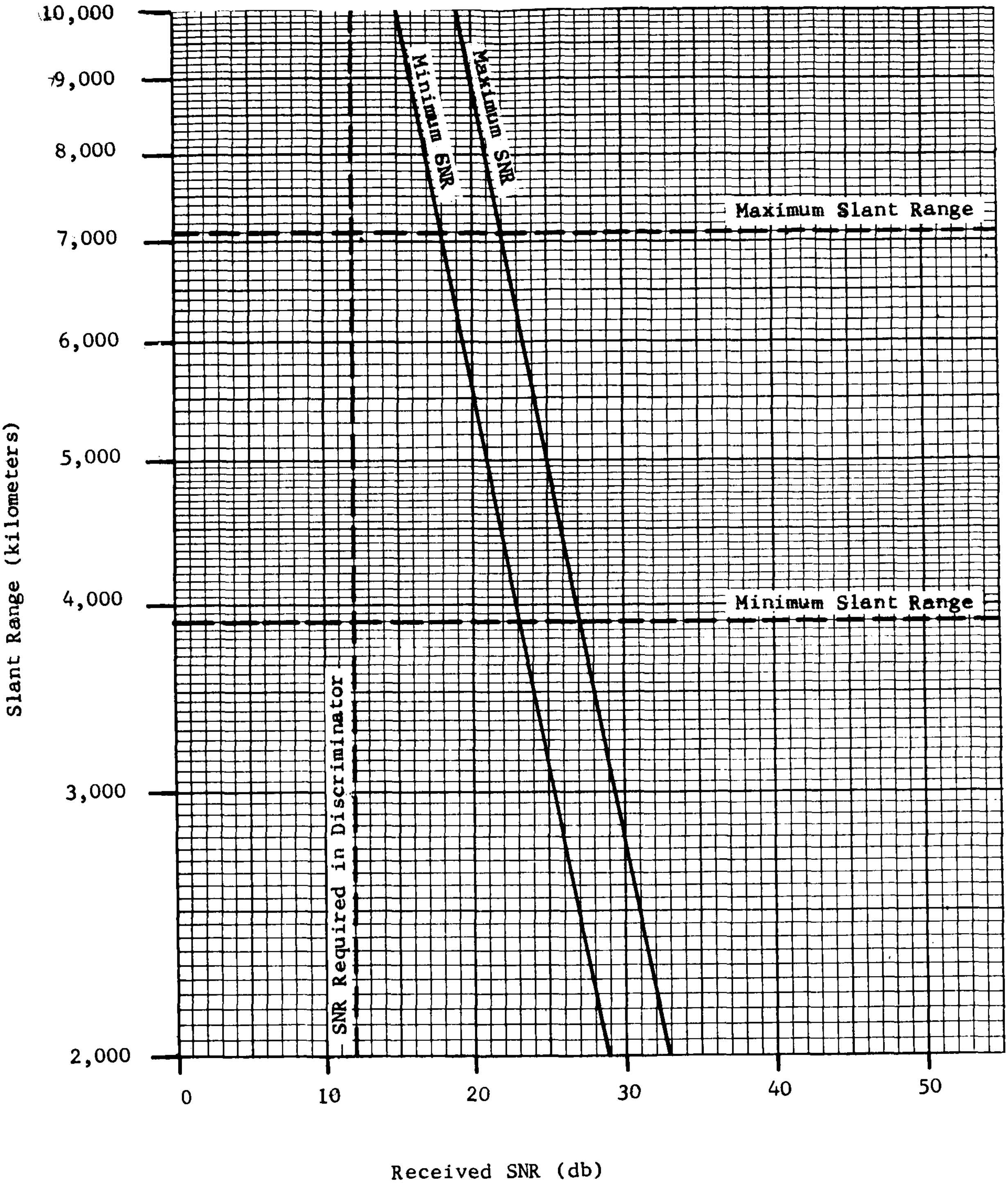


Figure A-2. Received Signal-to-Noise Power Ratio, 9-Yagi Antenna System (Diversity Polarization Telemetry Reception).

APPENDIX A

BIBLIOGRAPHY

1. Support Instrumentation Requirements Document, Project: Aurora I; NASA/GSFC, 20 April 1967

2. STADAN Facilities Report; NASA/GSFC # X-530-66-33, December, 1965

3. Handbook of NASA/GSFC Tracking, Data Acquisition and Communications Antennas; NASA/GSFC # X-525-64-222

4. "Design Curves Speed Antenna Polarization Loss Calculations", R. Hartop, Microwaves; August 1964

5. Aurora I project personnel

6. Network Assurance Group; Code 530, NASA/GSFC

APPENDIX B

AURORA-1 POTENTIAL RF CONFLICTS

APPENDIX B

POTENTIAL FREQUENCY CONFLICTS

(AURORA I)

No present or known scheduled spacecraft are allotted the frequency band allotted the Aurora I spacecraft, 137.140 MHz $\pm$ 15 kHz.

APPENDIX C

STADAN FEILD STATION RESPONSIBILITIES

APPENDIX C

STADAN FIELD STATION RESPONSIBILITIES

Table C-1 provides a cross-reference of individual STADAN station responsibilities. Under each heading are listed the paragraphs within the text that relate to specific station responsibilities and procedures.

Table C-1

STADAN Station Station Cross-reference Index

Stations	Tracking	Data Acquisition	Command	Recording Requirements	Quick-look	Transmittal Procedures	Communications
Fairbanks, Alaska	Not Required	6.3.1	Not Required	5.3.5	Not Required	6.6	7.1 7.2
Fort Myers, Florida	Not Required	6.3.1	Not Required	5.3.5	Not Required	6.6	7.1 7.2
Johannesburg, South Africa	Not Required	6.3.1	Not Required	5.3.5	Not Required	6.6	7.1 7.2
Orroral, Australia	Not Required	6.3.1	Not Required	5.3.5	Not Required	6.6	7.1 7.2
Quito, Ecuador	Not Required	6.3.1	Not Required	5.3.5	Not Required	6.6	7.1 7.2
Rosman, North Carolina	Not Required	6.3.1	Not Required	5.3.5	Not Required	6.6	7.1 7.2
Santiago, Chile	Not Required	6.3.1	Not Required	5.3.5	Not Required	6.6	7.1 7.2
Winkfield, England	Not Required	6.3.1	Not Required	5.3.5	Not Required	6.6	7.1 7.2

DISTRIBUTION LIST

DISTRIBUTION LIST

NOTE

All distribution is one each unless otherwise indicated.

Recipient	No. of Copies
Adams, R. H. Code 512	
Aucremanne, M. J. NASA Headquarters Code SG	2
Bavely, J. NASA Headquarters Code TN	
Berbert, J. H. Code 514	
Bodin, W. J. Code 530	
Brown, L. E. Code 532	
Buckley, E. C. NASA Headquarters Code T	
Byrd, V. H. Code 534	
Cassels, C. A. Code 572	6
Carter, E. J. Code 505	
Clark, J. F., Dr. Code 100	
Coates, R. J., Dr. Code 520	
Collins, R. W. Code 535	
Control Center Operations Manager Code 513	5
Creveling, C. J. Code 560	
Dunst, J. W. Code 263	
Ferris, A. G. Code 510	
I. Y. Galicinao Code 530	
Garbarini, R. F. NASA Headquarters Code F	3
Gorman, T. P. Code 565	
Gridley, D. H. Code 540	
Habib, E. J. Code 560	
Healy, William Code 511	
Humphrey, F. S. Code 573	
Kiebler, J. W. Code 510	
Kohout, J. M. Code 541	3
Lagow, H. E. Code 300	
Goddard Library Code 252	5

Recipient	No. of Copies
Matthews, N. W. Code 710	5
Mazur, D. Code 700	
Mengel, J. T. Code 500	3
Mentges, C. W. Code 541	
Meredith, L. H. Code 610	
Moore, E. Code 513	
Network Controller Code 530	10
Network Support Team Code 530	
Newell, H. E., Dr. NASA Headquarters Code S	
OPSCON Code 512	20
PIO Code 202	3
Poland, W. Code 563	
Powers, E. F. Code 530	
Quirey, E. Code 512	
Richardson, B. Code 541	
Stroble, R. R. Code 511	3

Recipient	No. of Copies
Rogers, W. B. Code 572	
Rosenberg, A. C. Code 564	6
Schroeder, C. A. Code 502	
Segal, R. L. Code 301	
Shaffer, H. W. Code 530	
Shapiro, A. Code 543	
Siry, J., Dr. Code 570	3
Stelter, L. R. Code 570	2
Stewart, D. J. Code 547	
Stockwell, E. J. NASA Headquarters Code TN	
Stotler, H. J. Code 546	
Stout, Curtis Code 560	
Surgen, H. R. Gatehouse	
Systems Review Office Code 301	
Technical Reference Control Facility Code 530	2

DISTRIBUTION LIST

Recipient	No. of Copies	Recipient	No. of Copies
Mr. Chester A. Matthes NASA Radio Tracking Facility Daniels Road, Route 5 P. O. Box 499 Fort Myers, Florida 33901		CINCNORAD ENT Air Force Base Colorado Springs, Colorado 80912 (NITA-S, NOOP-S, NINT)	3
Mr. E. J. Eisele NASA DAF Facility P. O. Box 1307 Fairbanks, Alaska 99701			
Mr. Leo B. McGee NASA Satellite Tracking Station c/o U. S. Embassy Quito, Ecuador			
Mr. Chester B. Cunningham NASA Director Tananarive Department of State Washington, D. C. 20520			
Mr. Richard M. Waetjen NASA Satellite Tracking Station Instituto Geofisico Del Peru Apartado 3747 Lima, Peru			
Mr. Victor M. Figueroa Box 12986 APO New York, New York 90283			
NASA, Communications Switching Center c/o Department of Supply 41 Jardine Street Kingston Australian Capital Territory Attn: Mr. R. K. Westbrook			
NASA, Communications Switching Center c/o Hawaiian Telephone Co. Box 2200 Honolulu, Hawaii 96821 Attn: Mr. J. P. Carbaugh			

Recipient	No. of Copies
Turnbull, H. A. Code 530	
Vaccaro, M. J., Dr. Code 200	
Wasielewski, E. W. Code 100	
Wiley, T. N. Code 571	
Army Map Service Washington, D. C. 20315	2
Benham, T. A. Haverford College Haverford, Pennsylvania 19041	
Chrisman, H. Head, Operational Research Branch Naval Research Laboratory Washington, D. C. 20390	
Command General U. S. Army Electronics Command Attn: AMSEL-BL-DP Mr. Steelman Fort Monmouth, New Jersey 07703	
Director Naval Research Laboratory Code 5332 Washington, D. C. 20390	
Fielder, D. NASA Manned Spacecraft Center Houston, Texas 77058	
1st AEROSPCONT Sqdn. ENT Air Force Base Colorado Springs, Colorado 80912	3

Recipient	No. of Copies
Peterson, C. M. Chief of Communications Smithsonian Astrophysical Observatory 60 Garden Street Cambridge, Massachusetts 02138	28
Rettie, R. S., Dr. National Research Council Ottawa, Canada	2
Schwartz, J. KSC - ULO - WTR Post Office Box 425 Lompoc, California 93438	2
Sheppard, D. Head, Spacecraft and Vehicle Support Branch ULO-32 John F. Kennedy Space Center Kennedy Space Center, Florida 32899	10
Spacetrack R&D Facility Lawrence G. Hanscom Field Bedford, Massachusetts 01731 Attn: ESSXT	2
PMR Facility Hawaiian Area FPO San Francisco, Calif. 96628 Attn: HO 30	
Mr. M. Gary Dennis NASA Data Acquisition Facility P. O. Box 838 Rosman, North Carolina 28772	
Mr. Charles Lundstedt NASA STADAN Facility P. O. Box 727 Barstow, California 92313	

SPECIAL DISTRIBUTION LIST

Recipient	No. of Copies
Demas, G. Control Center Operations Manager Code 513	3
Friel, F. J. Code 505	1
Hoff, H. L. Code 530	1
Martin J. B. Code 533	3
Mitchell, R. L. Code 513	10
Soar, W. S. Code 547	1
Space Physics Operations Control Center Code 513	20
Stewart, L. L. Code 572	3
Professor Brian J. O'Brien Rice University Department of Space Sciences Houston, Texas 77001	20

Recipient	No. of Copies
ALASKA	10
CARVON	2 INFO
FTMYRS	10
JOBURG	10
KAUAIH	2 INFO
LIMAPU	2 INFO
MADGAR	10
NEWFLD	2 INFO
ORORAL	10
QUITOE	10
ROSMAN	10
SNTAGO	10
WNKFLD	10